Conservation of Momentum

Name: ____________________ Section: 2AL-___ Date performed: __/__/__

Lab station: _____ Partners: ____

Preliminaries

Make sure the dynamics track is level. One way to test this is to send a cart through two photogates which are about 20 cm apart. The times registered by the two photogates should be very close to equal. This observation should be valid regardless of which direction the cart is sent through.

Sending the cart one way:

$$\Delta t_1 = \underline{\hspace{2cm}} \qquad \Delta t_2 = \underline{\hspace{2cm}}$$

Sending the cart the other way:

$$\Delta t_2 = \underline{\hspace{2cm}} \qquad \Delta t_1 = \underline{\hspace{2cm}}$$

You probably found that the times weren't exactly equal. Why not?

Inelastic collisions

Launch two equal-mass carts with velcro bumpers towards each other at roughly equal speeds. Describe in words what happens, and explain your observations in terms of momentum and energy conservation.

Now arrange for a collision between a small cart and a large cart with velcro bumpers. The large cart will be at rest initially.

flag width = ________ m_{small} = ________ m_{large} = ________

Carry out the collision and fill in the following tables (the initial velocity of the small cart should lie between 0.4 m/s and 1.0 m/s). The small and large carts should stick together after they collide.

Before collision:

	Time Δt (s)	Velocity v_i (cm/s)	Momentum p_i (g cm/s)	Kinetic Energy K_i (J)
Small cart				
Large cart	XXX			
		Totals		

After collision:

<table>
<tr><td></td><td>Time
Δt (s)</td><td>Velocity
v_f (cm/s)</td><td>Momentum
p_f (g cm/s)</td><td>Kinetic Energy
K_f (J)</td></tr>
<tr><td>Small cart</td><td rowspan="2"></td><td rowspan="2"></td><td></td><td></td></tr>
<tr><td>Large cart</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Totals</td><td></td><td></td></tr>
</table>

$$\text{Percent change in } p = \frac{\Delta p}{p_i} \times 100\% \quad = \underline{\hspace{2cm}}$$

$$\text{Percent change in } K = \frac{\Delta K}{K_i} \times 100\% \quad = \underline{\hspace{2cm}}$$

Is momentum conserved in an inelastic collision? Explain.

Is kinetic energy conserved in an inelastic collision? Explain.

Elastic collisions

Now arrange for a collision between two small carts with elastic bumpers. Make sure their masses are equal (or very close — within 0.1–0.2 g) by securing extra mass to the smaller mass cart.

$m_1 =$ __________ $m_2 =$ __________

flag width #1 = __________ flag width #2 = __________

Carry out the collision and fill in the following tables.

Before collision:

	Time Δt (s)	Velocity v_i (cm/s)	Momentum p_i (g cm/s)	Kinetic Energy K_i (J)
Cart #1				
Cart #2	XXX			
		Totals		

After collision:

	Time Δt (s)	Velocity v_f (cm/s)	Momentum p_f (g cm/s)	Kinetic Energy K_f (J)
Cart #1				
Cart #2				
		Totals		

$$\text{Percent change in } p = \frac{\Delta p}{p_i} \times 100\% \quad = \quad \_\_\_\_\_\_\_\_\_\_$$

$$\text{Percent change in } K = \frac{\Delta K}{K_i} \times 100\% \quad = \quad \_\_\_\_\_\_\_\_\_\_$$

What happened to cart #1 after the collision?

Now arrange for a collision between a small cart and a large cart with elastic bumpers. The large cart will be at rest initially.

$m_{\text{small}} =$ ________ $m_{\text{large}} =$ ________

flag width (small) = ________ flag width (large) = ________

Carry out the collision and fill in the following tables.

Before collision:

	Time Δt (s)	Velocity v_i (cm/s)	Momentum p_i (g cm/s)	Kinetic Energy K_i (J)
Small cart				
Large cart	XXX			
		Totals		

After collision:

	Time Δt (s)	Velocity v_f (cm/s)	Momentum p_f (g cm/s)	Kinetic Energy K_f (J)
Small cart				
Large cart				
		Totals		

$$\text{Percent change in } p = \frac{\Delta p}{p_i} \times 100\% \quad = \underline{\qquad\qquad}$$

$$\text{Percent change in } K = \frac{\Delta K}{K_i} \times 100\% \quad = \underline{\qquad\qquad}$$

Explain how you measured both the initial and final times for the small cart when it passed through the same photogate twice. What was the final reading of that photogate?

Is momentum conserved in an elastic collision? Is this similar to or different from an inelastic collision? Explain.

Is kinetic energy conserved in an elastic collision? Is this similar to or different from an inelastic collision? Explain.

Exercises

How is the cart's speed calculated?
- (A) (distance between photogates)/(time between photogates).
- (B) (distance between photogates)/(timer reading).
- (C) (flag width)/(time between photogates).
- (D) (flag width)/(timer reading).
- (E) (width of photogate)/(timer reading).

While the cart flag is passing through the photogate, the cart's speed is
- (A) constant.
- (B) increasing.
- (C) decreasing.
- (D) The answer depends on which collision and which cart.

Explain:

What kind of collision would you expect when the elastic bumpers are used?
- (A) Completely inelastic, with retention of nearly all kinetic energy.
- (B) Completely inelastic, with much loss of kinetic energy.
- (C) Almost perfectly elastic, with retention of nearly all kinetic energy.
- (D) Almost perfectly elastic, with much loss of kinetic energy.
- (E) None of the above.

What kind of collision would you expect when the velcro bumpers are used?
- (A) Completely inelastic, with retention of nearly all kinetic energy.
- (B) Completely inelastic, with much loss of kinetic energy.
- (C) Almost perfectly elastic, with retention of nearly all kinetic energy.
- (D) Almost perfectly elastic, with much loss of kinetic energy.
- (E) None of the above.

Is it possible for two moving objects to have a total momentum of zero? Explain.

Is it possible for two moving objects to have a total kinetic energy of zero? Explain.